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Population estimate of Asian Water Buffalo and wild cattle in the Arafura Swamp, central Arnhem Land

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Abstract

An aerial survey of Asian Water Buffalo *Bubalus bubalis* and wild cattle *Bos taurus* was undertaken in the Arafura Swamp region of central Arnhem Land in September 2005. The survey covered 3 089 km² and included the Arafura Swamp, nearby Blyth River, Glyde River floodplains, Goyder River and the floodplains of the Gulbuwangay River. A total of 812 individuals was recorded during the survey, 40% being Asian Water Buffalo and 60% wild cattle. The survey area was estimated to have a buffalo population of 5 187 (95% CI, 2 108 - 8 266) and a wild cattle population of 4 333 (95% CI, 1 827 - 6 839). These estimates are corrected for perception and availability bias. The traditional owners' objective is to manage the buffalo population for subsistence and commercial use. The data presented in this paper will be useful in planning for this development and as a basis for future management and monitoring of both buffalo and wild cattle populations.

Introduction

The Asian Water Buffalo *Bubalus bubalis* was introduced into northern Australia from South-east Asia between 1826 and 1866 (Letts *et al.* 1979). They became wild when some of the early British settlements were abandoned and have since occupied all major habitat types in the Northern Territory north of latitude 16° S (Skeat *et al.* 1996). An industry utilising buffalo hides started in the 1880s and this kept buffalo populations in check until the industry collapsed in 1956. After this buffalo numbers grew exponentially until they were declared an environmental nuisance in 1978 (Letts *et al.* 1979, Tulloch & Cellier 1986). In 1985 there were approximately 340 000 buffalo (mainly feral) spread over an area of 223 672 km² (Bayliss & Yeomans 1989). In an attempt to eliminate bovine tuberculosis (*Mycobacterium bovis*) from Top End feral and domestic bovids, a control campaign was undertaken between 1985 and 1989 as part of the national Brucellosis and Tuberculosis Eradication Campaign (BTEC) (Boulton

& Freeland 1991). This program significantly reduced buffalo numbers, especially in western Arnhem Land.

Cattle were introduced to Australia during the latter half of the 19th century and the early 20th century owing to a period of broad-scale pastoral settlement. The three species of cattle in Australia are the European breeds of *Bos taurus*, the humped cattle or Zebu breeds of *Bos indicus* and the Banteng *Bos javanicus*. All three are closely related and interbreed freely, although Banteng are restricted to the Cobourg Peninsula where they were first released in 1849 to provide meat for the fledgling British military outpost of Port Essington (Letts *et al.* 1979). Only the European and Zebu breeds are used for commercial beef production and some of these are wild because they have escaped from pastoral properties or have been left unmanaged on large stations. Many such wild cattle were shot in northern and central Australia as part of the BTEC.

The Arafura Swamp is situated in central Arnhem Land, approximately 550 km east of Darwin in the catchments of the Gulbuwangay and Goyder Rivers and is drained by the Glyde River (Figure 1). The area of the Arafura Swamp is 70 000 ha² in the dry season and can extend to 130 000 ha² in the wet season. It is an extensive permanent wetland which is significant as a breeding and refuge site for waterfowl and other wetland biota (Brennan *et al.* 2003, Williams *et al.* 2003). This is an internationally recognised wetland site listed under the RAMSAR Convention (Wetlands International 2006).

Although generally in good condition, wetland conservation values of the Arafura Swamp are becoming degraded through the increasing abundance and distribution of feral animals (particularly pigs and buffalo, but also horses, donkeys, cats and cane toads), localised planting of highly invasive exotic pasture grasses, and some incursions by livestock (Brennan *et al.* 2003, Williams *et al.* 2003). A recently published report, Arafura Swamp Water Resources Study (Williams *et al.* 2003), identified salt water intrusion as being the greatest threat to the integrity of the swamp; salt water is moving landward into the swamp at an average rate of 200 m $year^{-1}$ following a preferential path created by cattle *Bos taurus* tracks. At this rate it has been estimated that many of the large freshwater pools will be salinised within 10 years (Williams *et al.* 2003).

There has been a history of pastoralism in the area since the early 1970s when the Murwangi Pastoral Company was formed with a proposed lease covering all of the Arafura Swamp and most of the catchments. This was funded through the Aboriginal Development Corporation and the Methodist Overseas Missions with the aim of eventually transferring full control to local Yolngu people (Brennan *et al.* 2003). Murwangi Station officially commenced operation in 1975 but folded in 1982 through a lack of local interest. It then reopened in 1986 and was run by traditional land owners through the Murwangi Community Development Corporation (MCDC) which appointed an operations manager and ground staff. It had an operating abattoir until 2000 and supplied meat to Ramingining, Milingimbi and Elcho Island (Brennan

et al. 2003). Since then the abattoir has not been used commercially and Murwangi Station only supplies small amounts of meat to Ramingining. The MCDC Board have discussed the idea of destocking the northern plains of the Arafura Swamp of cattle and changing their focus to the harvest of wild cattle and buffalo in and around the swamp. In order to determine the feasibility of this option it is necessary to know the extent and distribution of the buffalo resource throughout the area. Therefore, the aim of this study was to estimate the number of Asian Water Buffalo and wild cattle in the Arafura Swamp.

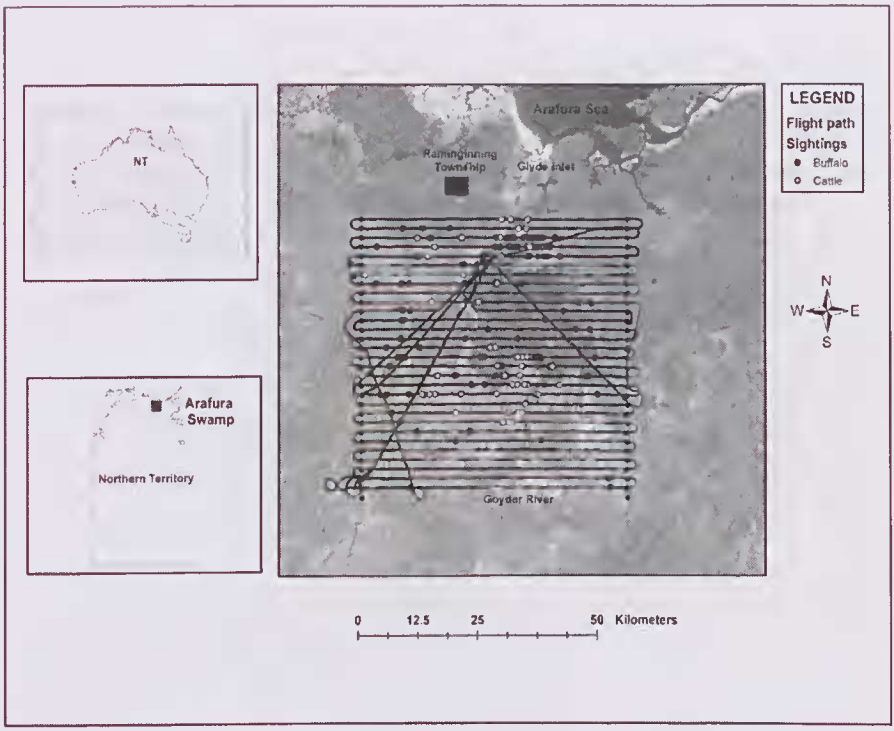

Figure 1. Map of the Arafura Swamp survey area showing its position, transect flight path and sighting of individuals/groups of buffalo and cattle.

Methods

Study area

A broad-scale aerial survey was conducted on the 8th and 9th of September 2005 to ascertain the distribution and abundance of Asian Water Buffalo and wild cattle in the Arafura Swamp region. The survey area was 3 089 km², and falls mainly within the Central Arnhem bioregion (Connors *et al.* 1996), and included the Blyth River to the west, Glyde River floodplains to the north, Goyder River to the south, and the floodplains of the Gulbuwangay River to the east (Figure 1).

Survey design

The survey methodology was based on established techniques for aerial survey of wildlife populations (Bayliss & Yeomans 1989, Caughley 1974, Caughley 1977, Caughley & Grigg 1982, Caughley *et al.* 1976). The sampling platform was a Cessna 206 high-wing aircraft equipped with a radar altimeter and Global Positioning System (GPS). The aircraft was flown at a mean altitude of 61 m (200 ft) above ground level and an average ground speed of 185 km h^{-1} (100 knots). The survey area was systematically sampled by east-west transects at 1.85 km spacing. A total of 30 transects was flown with a mean length of 55.6 km. Transect width was 200 m on each side of the aircraft. This represents a survey intensity of 21.6% of the total survey area. The transect width was delineated by fibreglass rods attached to the aircraft wing struts. The flight crew consisted of a pilot and three observers seated in the starboard front, port rear and starboard rear of the aircraft. Observers were able to communicate with each other via aircraft intercom and the number of animals in each group sighted was recorded by each observer on a COMPAQ iPAQ pocket computer (Hewlett-Packard Co.) that had been programmed as a data logger. All pocket computers were synchronised to the nearest second to the Universal Time Coordinate (UTC) and the time was automatically recorded when sightings were entered. Flight paths were logged using a GPS100AVD (Garmin International), recording latitude, longitude, UTC date and time every two seconds. The latitude and longitude of each sighting was determined by matching the observer sighting log with the GPS position log using UTC date and time. Sighting locations determined in this way incorporate an error due to the time lag between the sightings of the animals by the observer and the recording of the data on the pocket computer. This error was in the order of 120 m (i.e. the distance travelled in 2 seconds at 185 km h^{-1}).

Population estimates were calculated using the ratio method (Caughley 1979). Aerial survey data potentially incorporates two types of bias that lead to underestimates of the true population size: perception bias and availability bias. Perception bias is a result of observers missing animals that are potentially visible, while availability bias arises when some animals are concealed from the observers (Marsh & Sinclair 1989). To account for perception bias we used the double-count method whereby data is

obtained by two starboard observers counting the same area simultaneously and is an adaptation of the Peterson mark-recapture estimate. The count of one observer is equivalent to the first capture and the count of the other observer is equivalent to the recapture/resighting (see Edwards *et al.* 2004 for a detailed description of methods). To account for availability bias, we used correction factors developed by Bayliss and Yeomans (1989).

Results

Due to significantly higher sighting rates by the single port observer compared with either starboard observers, the starboard team correction factor has been used to correct port observations rather than the individual starboard front or rear seat observer correction factors as per Edwards *et al.* (2004).

A total of 812 individuals were recorded during the survey, 322 (40%) being buffalo and 490 (60%) being wild cattle. Buffalo were observed in smaller groups (average size 3.6) but numerous groupings (90 groups sighted) compared to cattle which had larger groups (average size 8) but less numerous groups (61 groups sighted).

Buffalo were observed at highest densities in the paperbark swamps north-east of Murwangi Station in the northern part of the swamp where the swamp drains into the Glyde River (Figure 1). Cattle were also concentrated in this area but there seemed to be a greater concentration at the southern end of the Arafura Swamp in the paperbark swamps just west of where the Goyder River enters the swamp (Figure 1).

The population estimates (corrected for perception bias but not for availability bias) of buffalo and wild cattle in the Arafura Swamp survey area were 2 702 (S.E.± 802) and 2 642 (S.E.± 764) individuals, respectively. Using this population estimate (uncorrected for availability bias) and the standard error based on the variation between transects it is possible to state with 95% confidence that the buffalo population in the survey area is between 1 098 and 4 303 individuals in size. Similarly, the wild cattle population could vary from 1 114 to 4 170 individuals.

The availability bias multiplier varies with habitat type and a multiplier of 1.27 and 2.57 has been recommended for buffalo and 1.40 and 1.89 for cattle in floodplain and woodland habitats respectively (Bayliss & Yeomans 1989). Our survey area was predominantly made up of these two habitat types so it would be reasonable to use an averaged multiplier of 1.92 for buffalo and 1.64 for cattle. Using the upper and lower confidence levels of the population estimate and the averaged multipliers for habitat type, the corrected buffalo population estimate is 5 187 (95% CI, 2 108 - 8 266) while the wild cattle population estimate is 4 333 (95% CI, 1 827 - 6 839). Using these corrected population estimates the density of buffalo and wild cattle in the Arafura Swamp survey area is 1.7 km^{-2} (95% CI, 0.7 - 2.7 km^{-2}) and 1.4 km^{-2} (95% CI, 0.6 - 2.2 km^{-2}), respectively. Note that these ranges do not account for the uncertainty

associated with the estimate of availability bias; actual 95% confidence intervals including this uncertainty would be larger.

Discussion

The extent and intensity of environmental impacts from buffalo varies greatly, depending on the landform type (upland, lowlands, floodplain and flood basin) of a region and the unique set of characteristics (combination of soils, topography, drainage and vegetation) associated with these areas (East 1990). Much of the research that has quantified environmental impacts of buffalo has been in the Kakadu region (East 1990, Skeat *et al.* 1996, Werner 2005), and the impacts include the reduction and removal of vegetation, changes in plant composition due to overgrazing and trampling, soil compaction, and damage to soil structure contributing to soil erosion (Skeat *et al.* 1996). Other longer term studies have found correlations with buffalo presence, fire patterns and tree growth and survival (Werner 2005). It must be noted that buffalo density was extremely high in certain areas of the Kakadu region and at their peak in the 1980s the mean density of buffalo at Kapalga research station was estimated as being 15 km^{-2} in open forest compared with 34 km^{-2} at the edge of the floodplain (Ridpath & Waithman 1988). It appears that buffalo are responsible for adverse and long-term environmental damage but management options are limited due to the expense of controlling their numbers in remote and inaccessible habitats.

The buffalo density (when corrected for perception bias only) in the Arafura Swamp was calculated at 0.87 ± 0.26 km^{-2}, which is similar to the buffalo density estimates of 0.74 ± 0.08 km^{-2} from a survey of the nearby Mann River district in 2001 (Koenig *et al.* 2003) and a 1998 survey for a similar area of 0.85 km^{-2} (K. Saalfeld, unpubl.). The landform types in the Arafura Swamp survey area are predominantly a mixture of floodplain and open woodland and the estimated buffalo densities are relatively low in comparison to the pre-BTEC population mean density in Kakadu National Park of 5.6 km^{-2} (Skeat *et al.* 1996).

Wild cattle estimates made during a survey of the Mann River district (Koenig *et al.* 2003) were much lower (0.10 ± 0.04 km^{-2}) compared with those of the Arafura Swamp area (0.86 ± 0.25 km^{-2}). The density estimates of wild cattle in the Mann River District were similar to those reported in the 1998 Arnhem Land feral animal survey (Saalfeld 1998). The higher densities around the Arafura Swamp are most likely to be caused by breakaways from Murwangi Station which operated as a pastoral lease between 1975 and 2000 (Brennan *et al.* 2003).

The Arafura Swamp is an internationally recognised wetland and as such has environmental qualities that need protecting. This area is on Aboriginal freehold land and has spiritual and cultural significance to the traditional owners. Cattle and buffalo are of great subsistence value to Aboriginal people in Arnhem Land (Altman 1987, Vardon *et al.* 1996) with the latter providing a commercial income through 'safari' and

tourism ventures (Johnson 2000). The Aboriginal resource centre in this area, MCDC, is looking at a number of economic opportunities that match the expectations and skills of the people in this region, and commercial utilisation of buffalo is one of these options. Managing feral pest populations is both time consuming and expensive (Boulton & Freeland 1991, Ridpath & Waithman 1988) and if there is any opportunity to create sustainable enterprise through careful monitoring and harvest of feral pests it should be encouraged and supported. The Aboriginal people from this area are well aware of the impacts that cattle and buffalo are having on the hydrology, flora and fauna of the swamp through recent research (Brennan *et al.* 2003, Williams *et al.* 2003) and this survey has provided additional information to assist them in their future management decisions.

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Asian Water Buffalo *Bubalus bubalis* (two animals on left of photograph) mixing freely with a herd of domestic cattle in central Arnhem Land, northern Australia. (Clive R. McMahon)